INSTRUCTION MANUAL

MODEL HR60-2.5B

MEDIUM POWER HALF RACK SERIES

TRANSISTORIZED POWER SUPPLY

TRYGON® ELECTRONICS, INC.
111 Pleasant Avenue
Roosevelt, New York 11575

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NOTICE

This Instruction Manual provides general characteristics, operating procedures, theory of operation, maintenance and calibration procedures and includes a complete schematic, troubleshooting guide and parts list pages for the model (s) listed on the front cover.

Any questions concerning this documentation should be directed to the Publications Dept., Trygon Electronics Inc., Roosevelt, N.Y., 11575.

Questions concerning the operation and application of Trygon power supplies should be directed to the Applications Engineering Dept., at the above address.

MEASUREMENT OF REGULATION AND RIPPLE

The specifications cited herein for regulation and ripple can be readily attained on every Trygon power supply, provided the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration section test procedures, must be connected to the sensing terminals and sensing terminals will yield an inaccurate regulation and ripple measurement.

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SECTION 1
DESCRIPTION

1.1 INTRODUCTION

The Medium Power Half Rack Series power supplies are flexible and dependable sources of D.C. power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes these units well suited for use as basic laboratory power sources. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

All components used in the construction of the Medium Power Half Rack units are of the highest quality available, and have been subjected to 100% incoming inspection.

Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. All silicon transistors have been "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units, and all zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, Sensing and Remote Programming terminals are located on a terminal board mounted on the rear panel of the unit. The AC power switch, AC pilot lamp, current mode indicator lamp, current and voltage controls and appropriate metering devices are all located on the front panel. For convenience, additional output terminals have been provided on the front panel.

Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the preset limiting current value determined by the front panel current control settings.

Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The crossover point is adjustable, and can be established anywhere within the current and voltage range of the unit.

Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere between 1% of the rated current output and maximum rated current output of the unit. In the event of a short circuit, the output voltage will drop to zero, and will return to its previous level only upon removal of the short circuit.

Precision Current Regulation

The Trylink Precision Current Regulation Mode provides a means, through special circuitry, of increasing the current regulation and overall stability of the unit. This mode may be placed into operation by changing rear panel shorting link connections, as outlined in Table 2-2.

Automatic Overvoltage Protection (Optional Feature)

Automatic Overvoltage (OV) protection prevents the output voltage from exceeding approximately 10% or 1.5 volts above the programmed voltage. An internal sensitivity control is provided to desensitize the overvoltage protection circuit.

Remote Programming

Remote Programming is provided in the voltage mode of operation, and may be utilized over the entire voltage range of the unit. The scale factor for Remote Voltage Programming is 100 ohms per volt.

1.3 PRECAUTIONARY MEASURES

Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.75 ohms.

Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which non-sinusoidal AC sources may not provide.

Systems Considerations

In systems applications it is recommended that each power

supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input without shielding. To keep the AC ripple in the output to a minimum, it is recommended that the AC input cables should not be run in close proximity to the output load cables.

Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

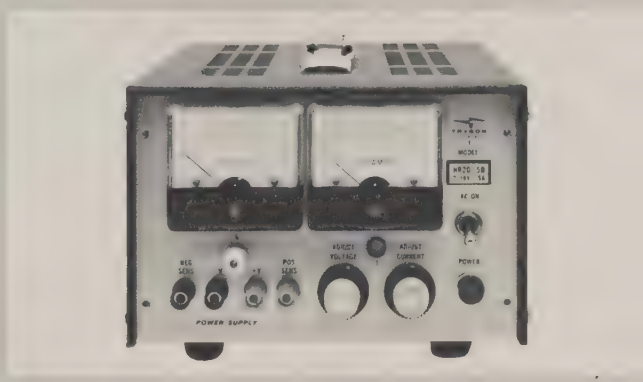
TRANSISTORIZED POWER SUPPLIES

MEDIUM POWER HALF RACK SERIES

HR(B) Series

OUTPUT:	0-20 VDC/0-40 VDC /0-60 VDC/0-160 VDC
REGULATION, LINE:	0.01% or 2 mv
LOAD:	0.01% or 3 mv
RIPPLE:	Less than 0.5 mv RMS
INPUT:	105-125 VAC, 55-65 cps

CONSTANT VOLTAGE/CONSTANT CURRENT



FEATURES

- ALL SILICON DESIGN
- TRYLINK PRECISION CURRENT REGULATION MODE
- MODE INDICATOR LIGHT
- AUTOMATIC SHORT CIRCUIT PROTECTION
- REMOTE VOLTAGE PROGRAMMING
- REMOTE SENSING
- SERIES OR PARALLEL OPERATION
- NO TURN ON/TURN OFF TRANSIENTS
- OVERVOLTAGE PROTECTION OPTION

ELECTRICAL SPECIFICATIONS

CONSTANT VOLTAGE MODE WITH ADJUSTABLE CURRENT LIMITING

INPUT: 105-125 VAC, 55-65 cps. (200-240 VAC, 50, or 400 cps available).
Output: Floating; isolated from ground, 300 VDC max.
REGULATION LINE: 0.01% or 2 mv,* for 105-125 VAC line change, at any output within specifications.
Regulation, Load: 0.01% or 3 mv,* no load to full load at any output within specifications.
Ripple: Less than 0.5 mv RMS.
Stability: 0.05% or 18 mv* for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient: (0.02% + 400 μv)/°C.
High Stability Option (X): 0.01% or 2 mv* with a T.C. of (0.01% + 100μv)/°C.
Temperature Range: −20°C to + 60°C.
Recovery Time: Less than 50 microseconds to recover within 0.05% or 15 mv* of output voltage for 100% step change in rated load.
Short Circuit Protection: Automatic Adjustable Current Limiting (ACL) variable from 1% to 100% of rated current.
AC Power Input Protection: Fuse.
Remote Programming: All units remotely programmable over output voltage range. Scale factor approximately 100 ohms/volt.
Remote Sensing: Maintains rated regulation directly at the load. Maximum line drop 0.5 volts per leg.
Voltage Adjustment Range: Continuously adjustable concentric vernier controls.

CONSTANT CURRENT MODE WITH ADJUSTABLE VOLTAGE LIMITING

Current Range: 1% to rated current output.
Voltage Compliance: 0 to rated output voltage.
Regulation, Line: 0.5% I_{rated} for 105-125 VAC line change at any output within specifications.
Regulation, Load: 0.5% I_{rated} output current change for the maximum change in load resistance within the rated voltage compliance range.
Ripple: 0.25% or 5 ma*.
Stability: 0.5% I_{rated} for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient: 0.1% I_{rated}/°C.
Remote Programming: Available on special order.

TRYLINK PRECISION CURRENT REGULATION MODE

Current Range: 1% to rated current output.
Voltage Compliance: 0 to rated output voltage.
Regulation Band: 0.1% I_{rated} total — line regulation, load regulation, and 8 hour stability (after warm-up)—for any input or output within specifications.
Ripple: 0.02% or 1 ma.*
Temperature Coefficient: 0.1% I_{rated}/°C.
*Whichever is greater

TABLE 1

Model	OUTPUT Volts	OUTPUT Amps	*Impedance DC-1KC	DIMENSIONS W	H	D	Weight (lbs.)
HR20-5B	0-20	0-5	0.004	7¾	4⅞	14	23
HR20-10B	0-20	0-10	0.002	7¾	4⅞	14	27
HR40-3B	0-40	0-3	0.008	7¾	4⅞	14	23
HR40-5B	0-40	0-5	0.004	7¾	4⅞	14	26
HR40-7.5B	0-40	0-7.5	0.004	7¾	4⅞	14	26
HR60-2.5B	0-60	0-2.5	0.008	7¾	4⅞	14	23
HR60-5B	0-60	0-5	0.004	7¾	4⅞	14	28
HR160-2B	0-160	0-2	0.008	7¾	4⅞	14	28

*Nominal

GENERAL AND PHYSICAL SPECIFICATIONS

Operational Modes: Constant Voltage with adjustable current limiting; Constant Current with adjustable voltage limiting; Automatic Crossover; TRYLINK Precision Constant Current with adjustable voltage limiting.

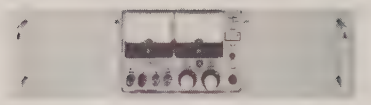
Mode Indicator: Front panel mode indicator light indicates when supply is operating in the constant current or current limiting mode.

Controls:
Voltage: Coarse and Fine; 0 to rated output; front panel.
Current: Coarse and Fine; 1% I_{rated} to rated output; front panel.
Input Power: Front panel switch and indicator.

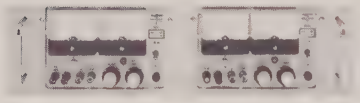
Metering:
Voltage: Front panel voltmeter.
Current: Front panel ammeter.

Terminals:
Front Panel: Pos. Output (+V) — Neg. Output (−V) — Pos. Sensing (+S) — Neg. Sensing (−S) — Ground (G).
Rear Panel: Pos. Output (+V) — Neg. Output (−V) — Pos. Sensing (+S) — Neg. Sensing (−S) — Ground (G) — Remote Voltage Programming (RVP) — Remote Current Programming (if included) (RIP) — TRYLINK connection (I, C)

Rack Mounting: RPA-1 (Single), RPA-2 (Dual) rack adapters, mounts two units side by side; 5¼" rack height, VPA-2 (Dual) rack adapter, mounts two units vertically.

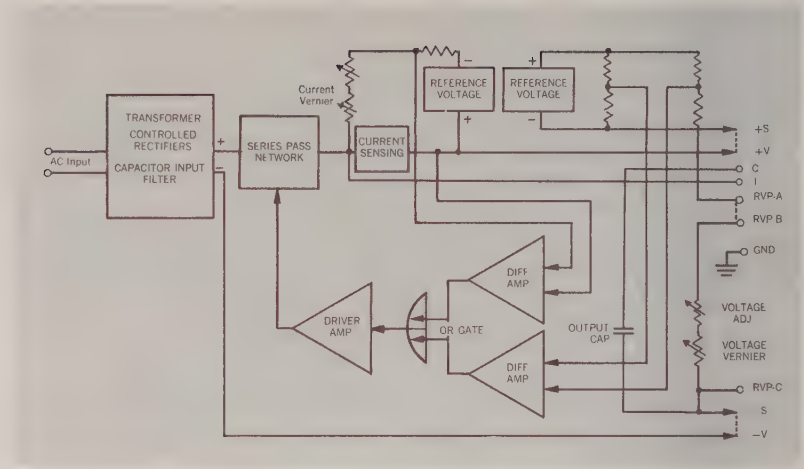


Rack Adapter RPA-1



Rack Adapter RPA-2

Two 19" wide rack adapters are available for mounting either one or two HR(B) Series units in a standard rack mount configuration.



Block Diagram—HR(B) Medium Power Half Rack Series

DESCRIPTION

• The Trygon All Silicon MEDIUM POWER HALF RACK SERIES units are designed for laboratory, bench, test, inspection, production and systems applications. Their unique design provides operating flexibility and high reliability at high power output levels.

• CONSTANT VOLTAGE and CONSTANT CURRENT operation is provided with automatic crossover from one mode into the other. In the voltage mode, adjustable current limiting is provided while the current mode provides adjustable voltage limiting. A mode indicator light on the front panel indicates when the unit is operating in the constant current or current limiting mode.

•TRYLINK PRECISION CONSTANT CURRENT CONNECTION provides increased current regulation. A simple rear panel link connection sets the unit into the TRYLINK mode.

• MAXIMUM RELIABILITY is achieved through the use of proven design techniques, component selection, and rugged construction. High quality components are used throughout and power transistors are generously derated and temperature aged, zener diodes are temperature stabilized, electrolytic capacitors are computer grade with rated life in excess of 10 years, transformers meet or exceed the requirements of MIL-T-27B, and all Trygon power supplies are manufactured in accordance with the Quality Assurance requirements of MIL-Q-9858. The Medium Power HR Series units carry the Trygon 5 year warranty.

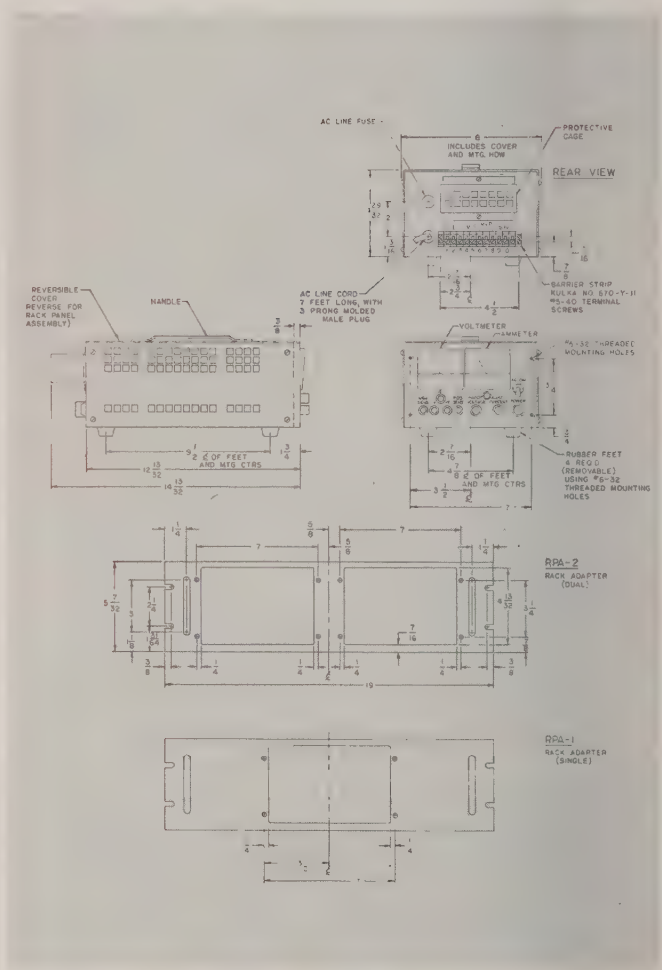
• AUTOMATIC TRACKING OVERVOLTAGE PROTECTION (OV)* is a patented automatic fail-safe overvoltage protection circuit pioneered by Trygon. The OV circuit protects the load against receiving a voltage in excess of the programmed output voltage of the supply. The protection point automatically tracks the programmed output voltage.

• SERIES OR PARALLEL OPERATION to increase voltage or current can easily be accomplished by connecting two or more supplies of this series together.

• SPECIAL MODIFICATIONS: The standard Medium Power HR Series Silicon Half Rack units are available in four voltage ranges. Their outstanding versatility, reliability, and operating convenience make them ideally suited for a large majority of applications in standard form.

• TRYGON ELECTRONICS, INC., has available a number of standard options and modifications to extend even further the range of performance or application of each power supply. In addition, the Trygon Application Engineering department is available for consultation on specific applications.

*Optional


AC LINE FUSE
PROTECTIVE CAGE
INCLUDES COVER AND MTG. HDW
REAR VIEW
BARRIER STRIP KULKA NO. 570-Y-11 #5-40 TERMINAL SCREWS
REVERSIBLE COVER REVERSE FOR RACK PANEL ASSEMBLY)
HANDLE
AC LINE CORD 7 FEET LONG, WITH 3 PRONG MOLDED MALE PLUG
VOLTMETER
AMMETER
#6-32 THREADED MOUNTING HOLES
RUBBER FEET 4 REQ'D (REMOVABLE) USING #6-32 THREADED MOUNTING HOLES
RPA-2
RACK ADAPTER (DUAL)
RPA-1
RACK ADAPTER (SINGLE)

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SECTION 2
INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

General

If the Medium Power Half Rack Series power supplies are used in a portable bench type configuration, no special mechanical installation is required. However, if the units are rack mounted, special rack mounting adapters must be used to secure the units to the relay racks. Single (RPA-1) and dual (RPA-2) rack panel adapters are available.

Rack Panel Adapter Mounting

A) Remove the 6-32 screws which fasten the cover to the power supply chassis.
B) Remove and rotate the cover so that the front is now facing to the rear.
C) Fasten the cover securely in position with the 6-32 screws previously removed.
D) Attach the handles to the Rack Panel Adapter.
E) Stand the Rack Panel Adapter in front of the power supply. In order to mount the power supply properly, the top of the Rack Panel Adapter must face up. The top is distinguishable from the bottom in that all the holes, including those for the handles, are in a straight row across the front of the Rack Panel Adapter.
F) Place the Rack Panel Adapter against the front panel, so that the four hbles in the adapter line up with the four holes in the front panel. Fasten the adapter to the front panel with four 6-32 x 1/2 screws.

2.2 ELECTRICAL CONNECTIONS

Input, Power

A heavy duty 3 wire line cord and molded plug with grounding prong provides a path for input power to the unit.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 - AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 feet or less	12
10 feet to 20 feet	10
20 feet to 50 feet	8
50 feet to 100 feet	6

Output, Rear Panel

An eleven terminal barrier strip mounted on the rear panel provides output, sensing, programming and ground connections. Table 2-2 SHORTING LINK APPLICATION, REAR PANEL, lists the various shorting link connections required for any of the various modes of operation.

Output, Front Panel

Five binding post terminals mounted on the front panel provide output, sensing and ground connections. Table 2-3 SHORTING LINK APPLICATION, FRONT PANEL, lists the various shorting link connections required for these modes of operation.

Front or Rear Panel Output Selection

Local or remote sensing and regulation is available from either the front or rear panel terminals. However, to maintain regulation, only one set of terminals may be used at a time. If the load is connected across the front panel output terminals, sensing (local or remote) connections must also be made from the front panel. If front panel output connections and rear panel sensing connections are made simultaneously to the load, regulation may deteriorate severely.

Shorting Link Application, Rear Panel

The power supply is shipped from the factory with shorting links in place across terminals 4 and 5, 7 and 8, and 9, 10 and 11, of the rear panel barrier strip. In this configuration, and with the load connected across the rear panel output terminals, local sensing and programming operation from the rear panel is provided.

Additional operating configurations may easily be achieved by changing shorting link connections or adding external wiring and controls, as outlined in TABLE 2-3 - SHORTING LINK APPLICATION, REAR PANEL. Any one of the four combinations of functions may be used in conjunction with either the CONSTANT CURRENT (selection A) or TRYLINK (selection B) modes of operation. However, the output of the power supply will become unregulated, unless the connections listed for at least one of the eight possible operating functions (A1-A4, B1-B4) are made.

TABLE 2-2 SHORTING LINK APPLICATION, REAR PANEL		
SELECTION	FUNCTION	CONNECTIONS REQUIRED
A	Constant Current	9 and 10; 10 and 11
B	Trylink	2 and 9; 10 and 11
1	Local Sensing Local Programming	4 and 5; 9, 10 and 11 7 and 8
2	Local Sensing Remote Programming	4 and 5; 9, 10 and 11 6 and 7; PGM resistor across 7 and 8
3	Remote Sensing Local Programming	10 and 11 9 and 10 connected at load(+) 4 and 5 connected at load(-) 7 and 8
4	Remote Sensing Remote Programming	10 and 11 9 and 10 connected at load(+) 4 and 5 connected at load(-) 6 and 7; PGM resistor across 7 and 8

NOTE: The shorting link between terminals 10 and 11 must be connected for all modes of operation.

Shorting Link Application, Front Panel

Shorting links for the front panel binding post terminals are shipped with the unit, but are not installed. Upon installation of these shorting links, front panel local or remote sensing operation may be selected. However, it must be remembered that if sensing connections to the load are made from the front panel, output connections must also be made from the front panel. Front panel shorting link connections are shown below:

TABLE 2-3 SHORTING LINK APPLICATION, FRONT PANEL

Terminals	Condition	Function
-S and -V +S and +V 9 and 11	Connected Connected Connected	Local sensing and regulation at front panel output terminals.
-S and -V +S and +V 9 and 11	Not Connected Not Connected Connected	Remote sensing and regulation at load, using four separate and individual leads to load.

NOTE: For front panel local or remote sensing operation, rear panel terminals 9 and 11 must be connected.

2.3 CONTROLS

Front Panel

TABLE 2-4 FRONT PANEL CONTROLS

Name	Function
AC POWER	Toggle switch, controls input power.
VOLTAGE ADJUST (Coarse)	Potentiometer, adjusts voltage output.
VOLTAGE ADJUST (Vernier)	Potentiometer, adjusts voltage output.
CURRENT ADJUST (Coarse)	Potentiometer, adjusts current.
CURRENT ADJUST (Vernier)	Potentiometer, adjusts current.

Internal

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

Grounding

Either side of the Output may be grounded, or the Output may be used in a floating condition.

Power On

Connect the power supply to a nominal AC power source. Set power switch S1 to AC-ON, and observe that pilot lamp DS1 glows.

Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommend to reach rated stability.

Series Operation

To operate two or more power supplies in a series configuration, connect the output of each power supply in series. When operating in this mode, it is necessary to adjust the output of each unit independently. The output voltage is equal to the sum of the voltage settings of each power supply.

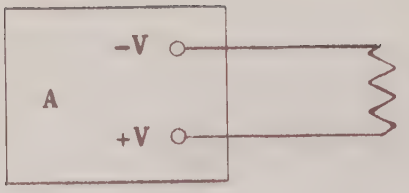
Parallel Operation

A) With rated resistive load connected across the output of power supply A as shown in Figure 2-1A, set VOLTAGE ADJUST control to desired output voltage and set CURRENT ADJUST control for maximum rated output current.

B) Connect power supply B as shown in Figure 2-1B. With no load across the output, set VOLTAGE ADJUST control for an output voltage 2 volts higher than the output voltage of power supply A. Place a short across the output terminals, and set the CURRENT ADJUST control for 1/2 the total load current requirement.

C) Remove all former output loads and connect the outputs of power supplies A and B in parallel with each other, and in parallel with the load, as shown in Figure 2-2.

D) If parallel operation of these two power supplies is desired for a systems application, it is important that both units be turned on simultaneously. It is therefore recommended that both power supplies be connected to a single large circuit breaker. Maximum output current will be twice that of either of the two power supplies, while minimum output current will be that of power supply B, or half the total load current.



R_L (Rated)

FIGURE 2-1A

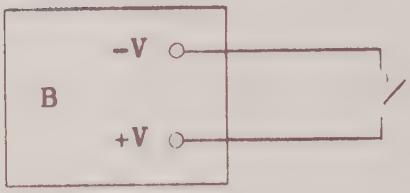


FIGURE 2-1B

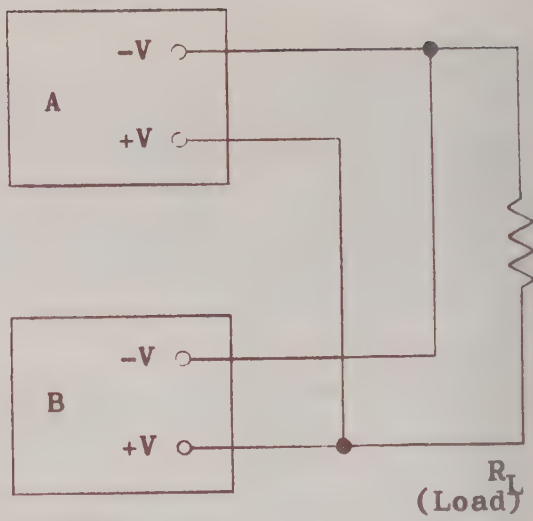


FIGURE 2-2

NOTE: If parallel operation of Trygon power supplies utilizing overvoltage (OV) protection is desires, the above procedure plus the following additional step must be performed:

1. Disconnect the gate lead from the OV SCR in power supply which is set to lower output voltage.

SECTION 3
THEORY OF OPERATION

3.1 GENERAL

The purpose of the Medium Power Half Rack Series power supplies is to transform and rectify the AC input into a well-regulated, stable and adjustable DC output. The following paragraphs describe the major circuits used in the power supplies. As each circuit is described, reference should be made to both the Block Diagram, Figure 3-1 and the Schematic Diagram in the rear of this manual.

Primary Input

Input power is obtained through power transformer T1, full wave rectifier diode sets CR1 and CR2, CR3 and CR6, CR4 and CR5, CR7 and CR8 (CR48 and CR49 HR160-2B) and CR26 and CR27, and filter capacitor C1, C16 and C17. Each rectifier set provides the necessary DC voltages to the various sections of the unit.

When AC power switch S1 is set to AC-ON, AC pilot lamp DS1 glows, and AC power is applied to the power transformer. Regulated DC output power is immediately available from the power supply.

Reference Supply

The rectified and filtered voltage from rectifiers CR1 and and CR2 and filter capacitor C1 is pre-regulated by Coarse Reference Regulator zener CR12. This provides a stabilized DC voltage to Constant Current Source Q2, whose output is regulated by Precision Voltage Reference zener CR14. Constant Current Source Q1 controls the drive to Q2 and in turn is controlled by Q2. The voltages developed across Constant Current Source References CR13 and CR14 are highly stable reference voltages established at a higher positive potential than the positive output of the supply.

Pre-Regulator

The purpose of the Pre-Regulator section is to maintain the unregulated input voltage on Input Filter Capacitor C16 at a suitable value compared to the output voltage in order to lower the power dissipation across the Series Pass section of the Series Regulator.

The method used to accomplish this is to "fire" a pair of SCR's (silicon controlled rectifiers), CR7 and CR8, at controlled points along the input sine wave to increase or decrease the potential to which the input filter capacitor may charge. The SCR's are "fired" (allowed to pass current) by the application of a positive pulse at the junction of gating resistors R55 and R56, from unijunction transistor Q11.

The unijunction transistor triggers the SCR's when charged sufficiently by timing capacitor C3 to cause conduction. The timing of the triggering pulse to the SCR's is a function of the voltage across Series Pass transistors and the AC voltage referenced by diode rectifiers CR3 and CR6, and Series Pass Voltage Adjust control R49.

The SCR's are turned off with each alternate half cycle of the input sine wave. Adjustment of R49 is factory set to the optimum full load diring point of the SCR's.

Series Regulator

The pre-regulated DC voltage from the SCR's is directed through the Series Pass transistors. The conduction of these transistors is controlled by circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the power supply to increase or decrease its output voltage or current.

To dissipate power within the Series Pass circuit when power is not being fed into a load, large current handling "throw off" resistors are placed in parallel with the Series Pass transistors. The throw off resistors are placed in a location remote from the Series Pass transistors, to reduce heat concentration and increase transistor life and reliability.

The Series Pass transistors are controlled by several driver stages which amplify signals from the error amplifier.

Comparator and Error Amplifier

The voltage sensing and comparison is accomplished by differential amplifier Q10. A sample of the output voltage on the base of Q10 is compared to the stable reference voltage on the base of comparator Q9. An unbalance caused by a change in voltage at either the negative sensing terminal or across voltage adjustment controls R25 and R26 will appear as a voltage change in the collector of Q10.

This difference voltage is amplified by error amplifier Q6, and is used to regulate the Series Pass transistors via the Series Pass drivers. Error amplifier Q6 has two diode inputs to its base which form an OR gate for error signals. CR17 supplies error signals from the comparator, and CR16 supplies an error signal in the event of a short circuit, or if the power supply is driven into the current limiting mode of operation.

When operating in the current limiting mode, differential amplifier Q3 and Q4 become balanced, causing diode CR16 to conduct, and in turn, drives error amplifier Q6 toward cut-off. This signal also causes Q7 to conduct, thereby causing current mode indicator lamp DS2 to glow.

3.2 OPTIONAL FEATURES

Overvoltage (OV) Protection

If the output voltage should rise above the programmed

output level, a portion of the signal developed across the OV sensitivity control will cause the OV sensor to conduct, which in turn, drives the OV Reference into conduction. The output of the OV SCR Driver is applied to the gate lead of the OV SCR, causing it to "fire". "Firing" of the OV SCR cuts off the Series Pass drivers and in turn, the Series Pass circuit.

If the overvoltage condition is caused by a short in the Series Pass circuit, the OV SCR will "fire", causing the OV fuse to open.

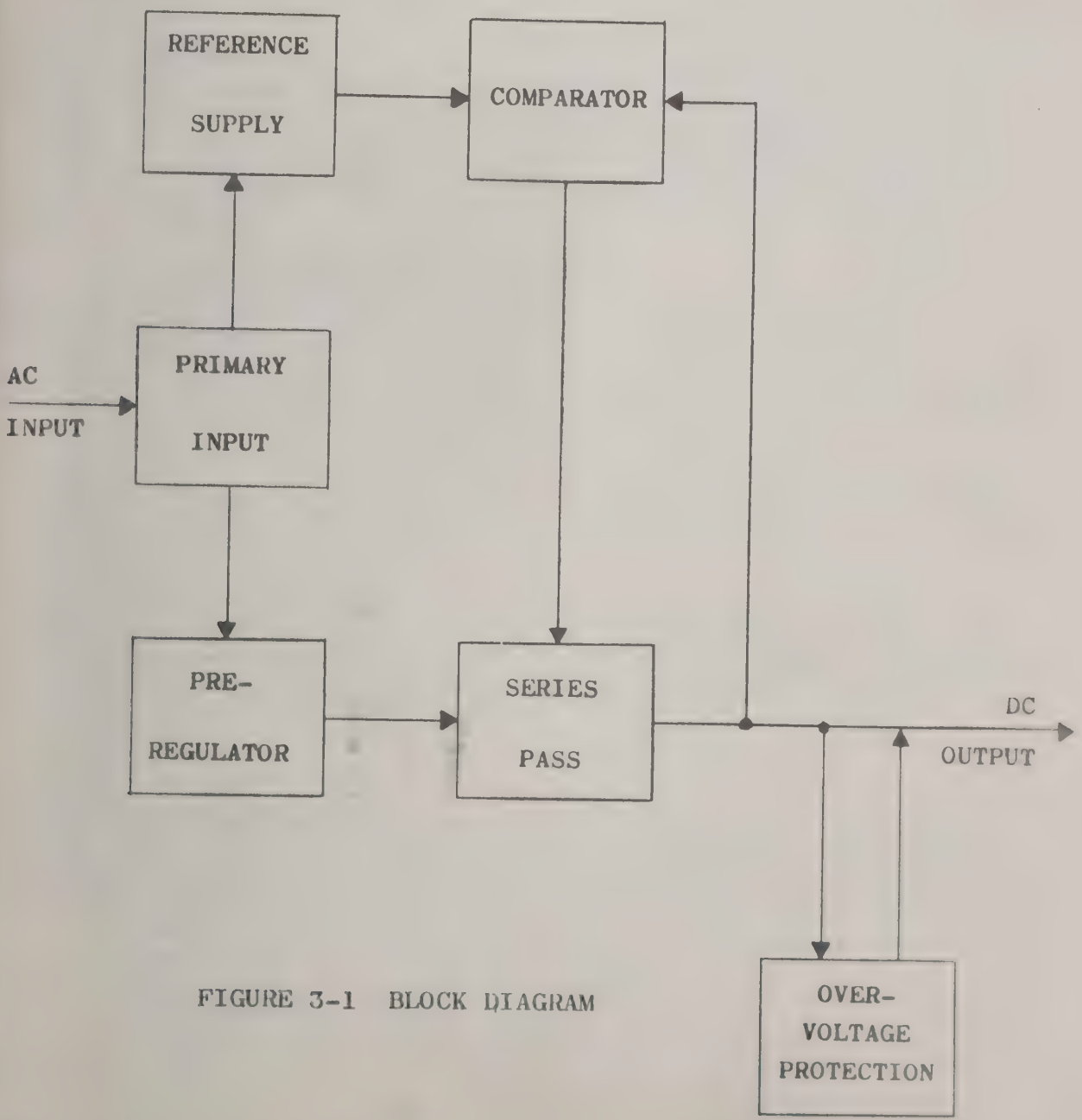


FIGURE 3-1 BLOCK DIAGRAM

SECTION 4

MAINTENANCE

- W A R N I N G -
High Voltages Are Present
Use Caution

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1. Disconnect all interconnections and loads to which the unit is normally connected.
2. Place shorting links between rear panel terminals 4 and 5, 7 and 8, and 9, 10 and 11. These connections must be securely made, or deterioration of output regulation will occur.
3. Connect a resistive dummy load across output terminals 4 and 10. This load should be of sufficient value to allow the unit to operate at its maximum rated current and voltage output.
4. Apply nominal AC input power to the unit and check for normal operation. Satisfactory operation at this time would indicate that any malfunction previously encountered, is external in nature. All interconnections and loads normally used in conjunction with this power supply should then be carefully checked for electrical defects.

4.3 TROUBLESHOOTING

1. Set VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Using a 20,000 ohms per volt voltmeter or oscilloscope, check the voltages across the various circuit components listed in the TROUBLESHOOTING GUIDE, located immediately before the schematic diagram at the rear of this instruction manual. The sample voltages listed in this guide apply only if the unit is operating at its nominal AC input, and has a dummy load of sufficient size connected across its output to allow operation at maximum rated current and voltage output levels. Any reading which is grossly

incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any trouble-shooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2. If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point-to-point resistance checks across pots, switches, diodes, resistors, transistors, in that order.

3. When the trouble is of an intermittent nature such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic changes will be necessary.

SECTION 5
CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the Trygon power supply.

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

(A) Oscilloscope, Tektronix Type 561
(B) Differential Amplifier Plug In, Tektronix Type 63
(C) Time Base Plug In, Tektronix Type 67
(D) Differential VTVM, Fluke Model 825A
(E) AC VTVM, Hewlett Packard Model 400D
(F) VOM, Simpson Model 260
(G) Variable Auto transformer, Powerstat Type 3PN136 (20 Ampere rating)

Shorting Link Application

For test purposes, shorting links should be connected across terminals 4 and 5, 7 and 8, and 9, 10 and 11, to provide local sensing and local voltage programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1 and Figure 5-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

5.3 CALIBRATION PROCEDURE

Pre-Regulator

A) With power supply operating without a resistive load across the output terminals, vary VOLTAGE ADJUST control until 100% of rated voltage output is indicated on the DC voltmeter. Set AC POWER switch S1 to OFF, and connect resistive load across the output terminals. Set AC POWER switch S1 back to ON, and adjust resistive load for rated current setting on ammeter.

B) Set oscilloscope to DC triggering mode and connect scope input across the positive terminals of input capacitor C16 and output capacitor C9.

C) Adjust Pre-Regulator Input Balance control R53 for a balanced 120 cps sawtooth shaped waveform.

D) Adjust Series Pass Voltage control R49 for approximately 10 VDC, measured between the positive terminals of input capacitor C16 and output capacitor C9.

E) Vary AC input power 10% above and below the nominal input level. Observe that the voltage measured between the positive terminals of the input and output capacitors, does not vary by more than 1.5 VDC, at either input voltage extreme.

Voltage Adjust Control

A) Maximum Voltage

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Adjust Maximum Voltage control R86 to obtain an output voltage 0.5 VDC in excess of the maximum rated output voltage.

B) Minimum Voltage

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW. Adjust Minimum Voltage control R87 to obtain a negative output voltage of 0.1 VDC.

C) Readjustment

Adjustment of either Maximum Voltage control R86 or Minimum Voltage control R87 will have an effect upon the other. Therefore, these controls should be readjusted if necessary, as outlined in above paragraphs (A) and (B), upon initial completion of this adjustment.

NOTE

If partial rotation of the VOLTAGE ADJUST controls produces no apparent change in indicated output voltage, further rotation of these controls should not be attempted. Rotation of these controls fully CCW with little or no output voltage regulation can result in damage to the controls, the load, or both. Set the AC POWER switch to OFF, and proceed with the troubleshooting outlined in Section 4 (MAINTENANCE) of this instruction manual.

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW and observe that the voltage indicated on the unit and test voltmeters drops slightly below the zero setting of the meters. The output voltage should be approximately negative 200 mv. Reset voltage controls fully CW.

Current Adjust Controls

A) Maximum Current

Connect a test ammeter having a full scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW.) Apply power to the unit under test and slowly rotate CURRENT VERNIER control fully CW. Observe that the maximum current obtainable is approximately 105% that of the maximum rated current output. If it is not possible to achieve 105% of the maximum rated current output, adjust Maximum Current control R37 until that value is attained. Set AC Power Switch to OFF.

Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC Power Switch to ON. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output and observe the voltage indicated on the Differential VTVM. The maximum change in output voltage should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, readjust Maximum Current control R37 slightly and recheck the load regulation.

B) Minimum Current

Connect test ammeter, having a full scale current indicating capacity of 100 ma, across output terminals in place of a load resistor. Set all front panel controls fully CCW and apply power to the unit under test. Slowly rotate VOLTAGE ADJUST control in a CW direction, until current meter indicates a current flow somewhere between 0-50ma. Adjust Minimum Current control R29 for a nominal current indication of 1% of the rated current. Set POWER ON switch S1 to OFF.

Constant Voltage Operation

A) Load Regulation

With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the Output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Differential VTVM should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Differential VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum change in output voltage should not exceed by more than 0.01% or 2mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed 0.5 mv RMS.

Constant Current Operation

A) Load Regulation

With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load back across the output terminals. Selection of the proper value for the current sensing resistor may be easily made using the formula $R_S = \frac{I}{I_R}$ where R_S = Value of Current Sensing Resistor and I_R = Rated Load Current. Connect the equipment as shown in Figure 5-2, and apply power to the power supply.

Vary the VOLTAGE ADJUST controls and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading, and that increasing the VOLTAGE ADJUST controls has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current Mode.

Measure the voltage across the small sensing resistor. Compute and note the current flow through this resistor. Change the output load from the resistive load previously used, to a short. Again measure the voltage across the small sensing resistor and compute the value of the current flow through this resistor. The change in current should not exceed by more than 0.5% the rated current previously noted with a full resistive load across the output.

B) Line Regulation

Replace the resistive load across the output and measure the voltage drop across the small sensing resistor. Compute and note the current flow ($I = \frac{E}{R}$) through this resistor.

Vary the input line voltage between 105 and 125 VAC. Note the maximum change in voltage across the sensing resistor and compute the maximum current flow. The maximum change in current should not exceed by more than 0.5% the rated current previously noted at either extreme of the AC input.

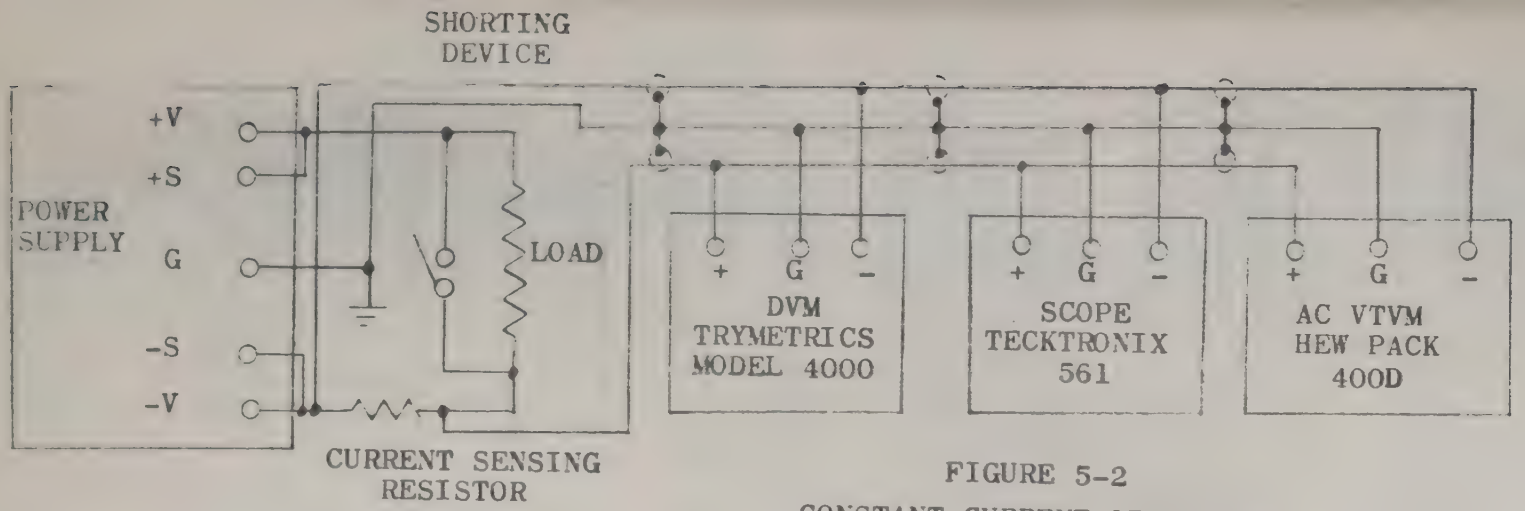


FIGURE 5-2
CONSTANT CURRENT OPERATION

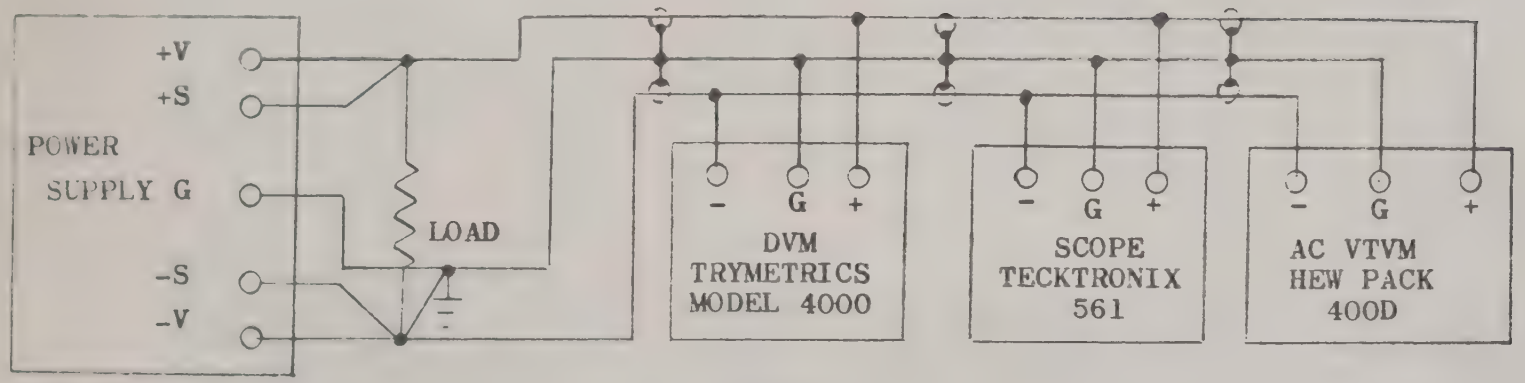


FIGURE 5-1
CONSTANT VOLTAGE OPERATION

C) Ripple Current

With the AC input line voltage adjusted to the nominal value of 115 volts and the resistive load connected across the output, measure the amplitude of the AC ripple as seen across the sensing resistor with the AC VTVM. Compute and note the current flow. Vary the AC input line voltage between 105 and 125 VAC. Measure the maximum voltage drop and compute the maximum current flow. The maximum ripple current must not exceed by more than 0.25% or 5 ma (whichever is greater) that of the current flow noted during nominal input line voltage.

Precision Current Regulation

Record the load regulation, line regulation and ripple current measurements obtained in steps A, B and C of above paragraph. Disconnect the rear panel shorting link between terminals 9 and 10. Connect a shorting link between terminals 10 and 11, and a shorting wire between terminals 2 and 9. Recheck load and line regulation and ripple current measurements as outlined under Constant Current Operation, Paragraphs A, B and C.

Observe that the regulation band for line and load as measured after an 8 hour stability (warm-up) period, does not exceed 0.1% of the rated current, for any input or output voltage within specifications; that the ripple current does not exceed 0.02% or 1 ma (whichever is greater) of the current flow measured at nominal line voltage; that the temperature coefficient does not exceed 0.1% of the rated current per degree centigrade change.

Overvoltage (OV) Sensitivity (Optional)

The sensitivity of the Overvoltage Protection circuit is determined by the setting of the Overvoltage Sensitivity control R106. This control is factory preset to cause a short circuit to be applied across the output of the unit if the output voltage attempts to rise more than 10% or 1.5 volts above the programmed voltage.

Although an internal control, the OV Sensitivity control is not "solder locked" in place as are the other internal controls, but may be varied to suit the individual needs of the user. **This control may be readjusted by removing the power supply cover.**

To determine the proper point at which the OV Sensitivity control should be set to automatically shut the unit off, connect the output of a second current limiting type power supply having a higher output voltage capability, in parallel with the unit under test. If a current limiting type supply is not available, a current limiting resistor must be connected between the two supplies. Set the output of the second unit 10% higher than that of the first unit. Adjust the OV Sensitivity control until the unit under test automatically shuts itself off.

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

TRANSISTORS

SEMI - CONDUCTOR PART NUMBERS		
TRYGON IBM NO.	TRYGON OR MFR P/N	JEDEC EQUIVALENT
700000	TR1132	2N1132
700001	2N3638A	2N3638A
700010	TR346	2N1556
700020	TR360	2N360
700030	TR361	2N652
700040	TR375	2N1533
700045	TR496	2N497A
700050	TR656	2N656
700060	TR890	
700070	TR951	2N2527
700080	TR1490	2N3055
700083	TR1493	2N1490
700085	TR1495	2N3442
700090	TR2060A	2N2060A
700110	TR2195	
700115	TR2905	2N3644
700180	16A507	2N2712
700181	2N3566	2N3566
700191	TR1591	2N3054
700193	TR1593	2N3441
700200	TR1512	2N2139
700205	TR1690	2N3440
700411	2N3569	2N3569
705018	2N3416	2N3416
705030	16J1	2N3605
705031	2N3691	2N3691
720055	TR83	
720145	UJ25	2N2647
720328	720328	

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

SEMI-CONDUCTOR PART NUMBER		
TRYGON IBM NO.	TRYGON OR MFR P/N	JEDEC EQUIVALENT
720060	E016	
720110	SV515	1N821
720144	UZ750	
720150	UZ815	
720181	1N751A	1N751A
720151	UZ806	
720182	1N754A	1N754A
720192	1N753B	1N753B
720196	1N755A	1N755A
720200	40108	1N1431
720210	40109	1N1342
720220	40110	1N1343
720230	40111	1N1344
720241	1N1360A	1N1360A
720260	TR2620A	1N2620A
720262	1N2163A	1N2163A
720273-720277	SCR285-2 thru SCR285-7	
720280	SCR93-2	2N2572
720290	SCR93-3	2N2573
720300	SCR93-4	2N2574
720301	SCR93-5	2N2575
720303	SCR93-7	2N2577
720330	70H10	
720340	70H15	
720350	70H20	
720384	1N4384	1N4384
720390	SSD708	
720393	1N972B	1N972B
720397	1N2165A	1N2165A
720394	1N964B	1N964B
720395	1N965A	1N965A
720440	TR4148	1N4148
720454	MR1031A	
720455	MR1032A	
720456	MR1034A	
720459	1N758	1N758
720464	1N968	1N968
720466	1N983A	1N983A
725016	1N702	1N702
725047	MR211 5B	
725048	MR211SBR	
725076	1N3616	1N3616
725130	2N3670	2N3670
720263	Z0132	

LIST OF ELECTRICAL PARTS - MFRS' CODE

1) The numbers designated in the SPARES column of the following LIST OF ELECTRICAL PARTS indicate the recommended spare parts requirement for support of this equipment for a period of one year.
2) For units equipped with either or both High Stability and Overvoltage options, the List of Electrical Parts pages so labeled contain appropriate additional and/or replacement parts listings.
3) The code designations listed in the MFR column of the LIST OF ELECTRICAL PARTS, have been assigned to the following manufacturers:

CODE	MANUFACTURER
A-B	ALLEN BRADLEY
BUSS	BUSS
CARL	CARLING
CD	CORNELL DUBILIER
CLAR	CLAROSTAT
CORN	CORNISH
CTS	CHICAGO TELEPHONE SUPPLY
GE	GENERAL ELECTRIC
GI	GENERAL INSTRUMENTS
HOYT	HOYT
IREC	INTERNATIONAL RECTIFIER CORP.
IRES	INTERNATIONAL RESISTOR CORP.
COMA	COMARK
FERI	FERI

CODE	MANUFACTURER
LEE	LEECRAFT
ARN	ARNOLD
MOTO	MOTOROLA
RCA	RADIO CORPORATION OF AMERICA
SAGE	SAGE
SANG	SANGAMO
SPRA	SPRAGUE
EBIE	ERIE
TRAN	TRANSITRON
TRY	TRYGON
UNI	UNITRODE
WL	WARD LEONARD
SEMC	SEMCORE
SEMT	SEMTECH

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Spares	
C1	Capacitor, 300 MFD, 60V	SANG	539-248 -02	1	
C2	Capacitor, .15 MFD, 250V	COMA	MET MYLAR	1	
C3,20	Capacitor, .1 MFD, 250V	COMA	MET MYLAR	2	
C4	Capacitor, 65 MFD, 50V	SANG	TYPE 556	1	
C5	Capacitor, .047 MFD, 250V	COMA	MET MYLAR	1	
C6	Capacitor, .0033 MFD, 600V	ERIE	CK62AW332M	1	
C7	Capacitor, .01 MFD, 600V	ERIE	81125V103P	1	
C9	Capacitor, 3300 MFD, 70V	SANG	500-115 -02	1	
C11	Capacitor, .22 MFD, 250V	COMA	MET MYLAR	1	
C16	Capacitor, 8000 MFD, 75V	SANG	500-115 -02	1	
C17	Capacitor, 18 MFD, 150V	CD	NLW18-150	1	
C19,25	Capacitor, .01 MFD, 250V	COMA	MET MYLAR	2	
C21	Capacitor, .001 MFD, 600V	ERIE	CK62BX1 2M	1	
C22	Capacitor, 8 MFD, 100V	SPRA	40D805F100D4	1	
C23	Capacitor, 20 MFD, 100V	SPRA	TE1409	1	
CR1-6,9,15-20 28,29,31,35	Diode	GI	G100B	10	
CR7,8	Rectifier, Silicon, Controlled	MOTO	SCR93-4	2	
CR10,11,13,22	Diode, Zener	TRAN	1N751	2	
CR12	Diode, Zener	HOFF	1N1360A	1	
CR14	Diode, Zener	SEMC	TR2620A	1	
CR26,27	Diode, Zener	SEMT	SC2	2	

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Spares	
CR33	Diode, Zener	GI	E016	1	
DS1	Pilot Light	IND. DEV.	1040A87	1	
DS2	Light Ind.	LEE	41N-G6-1317-9B5T	1	
F1	Fuse	BUSS	MDL10	5	
L1,L2	Core	ARN	A2060682	1	
M1	Meter, 0-60V	HOYT	B3127	1	
M2	Meter, 0-3A	HOYT	B3122	1	
P1	Cord, Line	CORN	18 3		
Q1,3-5,7-10,12 21	Transistor	GE	16A507	6	
Q2,6,13,18	Transistor	TRAN	TR1132	4	
Q11	Unijunction UJ25	GE	4JX5E600	1	
Q13	Transistor	GE	TR656	1	
Q14	Transistor	RCA	TR1591	1	
Q15,16,17	Transistor	RCA	TR1493	3	
R1	Resistor, 200Ω, 5W, 5%	WL	5XM200	1	
R2	Resistor, 9.95KΩ, .5W, 1%	IRES	CECTO	1	
R3	Resistor, 47KΩ, .5W, 10%	AB	RC20GF473K	1	
R4	Resistor, 1.18KΩ, .5W, 1%	IRES	CECTO	1	
R5	Resistor, 150Ω, .5W, 1%	IRES	CECTO	1	

LIST OF ELECTRICAL PARTS - STANDARD UNIT

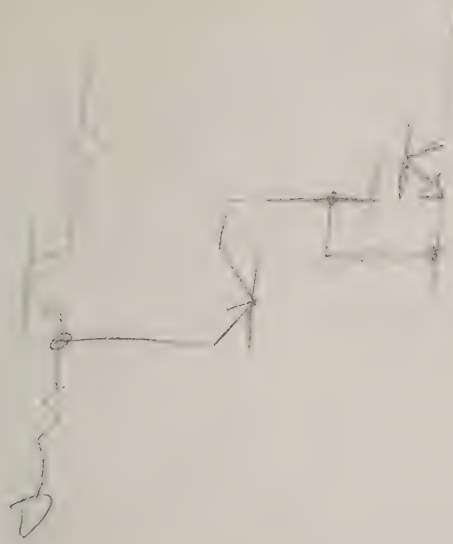
Designation	Component	MFR	Part Number	Spares	
R6,7,18,19,35 36	Resistor, 1.96KΩ, .5W, 1%	IRES	CECTO	3	
R8,20,73,89	Resistor, 100Ω, .5W, 10%	AB	RC20GF101K	4	
R9,16,21	Resistor, 750Ω, .5W, 1%	IRES	CECTO	3	
R10,41	Resistor, 470Ω, .5W, 10%	AB	RC20GF471K	2	
R11	Resistor, 1.92KΩ, .5W, 1%	IRES	CECTO	1	
R12,43,76,77	Resistor, 1KΩ, .5W, 10%	AB	RC20GF102K	3	
R13	Resistor, 560Ω, .5W, 10%	AB	RC20GF561K	1	
R14,60	Resistor, 100KΩ, .5W, 10%	AB	RC20GF104K	2	
R15	Resistor, 402Ω, .5W, 1%	IRES	CECTO	1	
R17	Resistor, 1.5KΩ, .5W, 1%	IRES	CECTO	1	
R22	Resistor, 511Ω, .5W, 1%	IRES	CECTO	1	
R23	Resistor, 200Ω, .5W, 1%	IRES	CECTO	1	
R24	Resistor, 50Ω, 3W, 3%	SAGE	1300S50-3	1	
R25,26	Potentiometer, 6K/100Ω, 2W DUAL	CLAR	B3116	1	
R28	Resistor, 4.7KΩ, .5W, 10%	AB	RC20GF472K	1	
R29	Potentiometer, 500Ω, 1.5W, 20%	CTS	110	1	
R31,84	Potentiometer, 125/10Ω, 2W, DUAL	CLAR	B3117	2	
R33	Resistor, .2Ω, 25W	IRES	2D	1	
R34	Resistor, 604Ω, .5W, 1%	IRES	CECTO	1	
R32	Resistor, 340Ω, .5W, 1%	IRES	CECTO	1	
R37,81,86,87	Potentiometer, 150Ω, 1.5W, 20%	CTS	110	4	

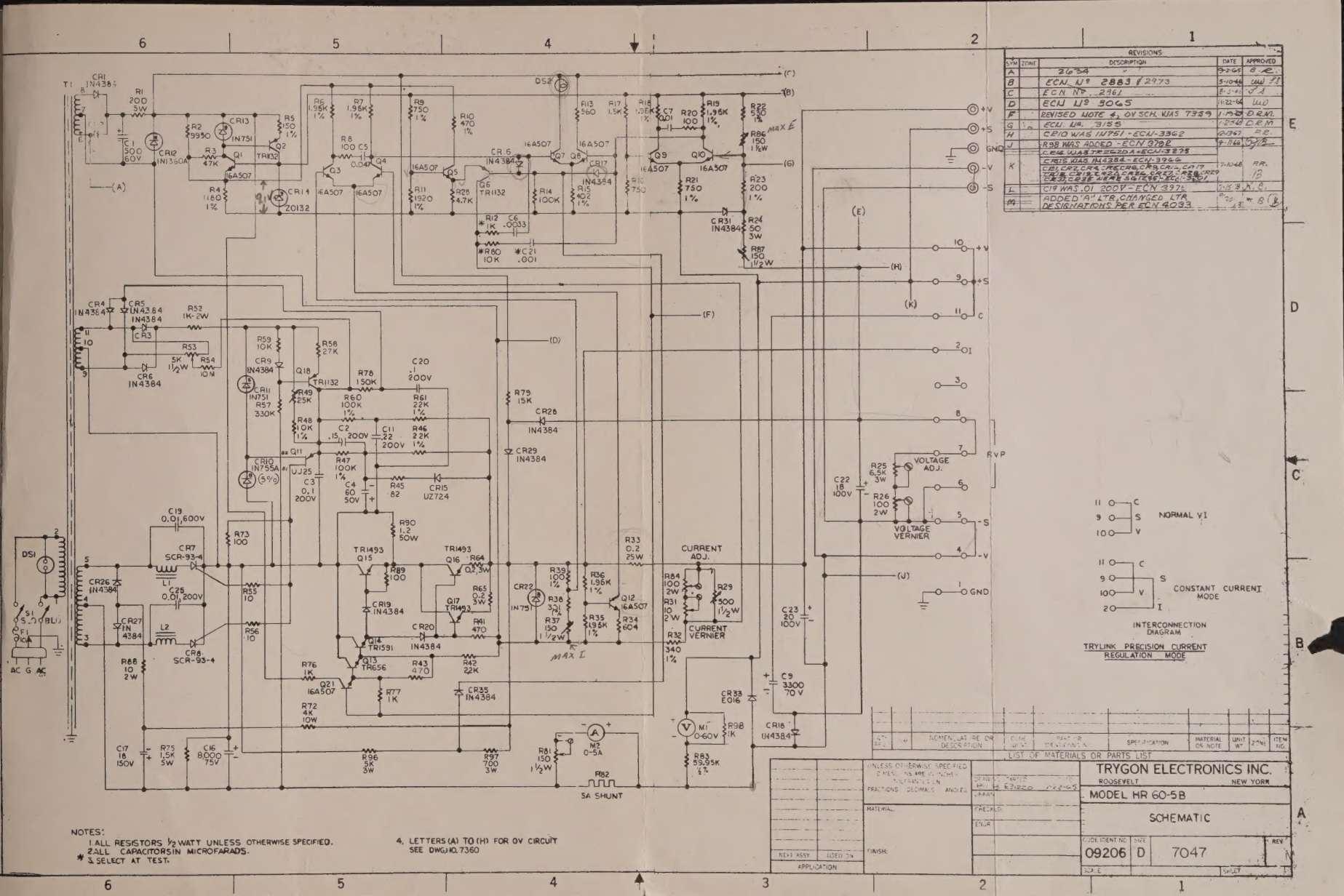
LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Spares	
R38	Resistor, 301Ω, .5W, 1%	IRES	CECTO	1	
R39	Resistor, 100Ω, .5W, 1%	IRES	CECTO	1	
R42	Resistor, 2.2KΩ, .5W, 10%	AB	RC20GF222K	1	
R45	Resistor, 82Ω, .5W, 10%	AB	RC20GF820K	1	
R46,61	Resistor, 22KΩ, .5W, 1%	IRES	CECTO	1	
R47	Resistor, 100KΩ, .5W, 1%	IRES	CECTO	1	
R48	Resistor, 10KΩ, .5W, 1%	IRES	CECTO	1	
R49	Potentiometer, 25KΩ, .25W, 10%	CTS	UPE200R	1	
R52	Resistor, 1KΩ, 2W, 10%	IRES	BWH	1	
R53	Potentiometer, 5KΩ, 1.5W, 20%	CTS	110	1	
R54	Resistor, 10MΩ, .5W, 10%	AB	RC20GF106K	1	
R55,56	Resistor, 10Ω, .5W, 10%	AB	RC20GF100K	1	
R57	Resistor, 330KΩ, .5W, 10%	AB	RC20GF334K	1	
R58	Resistor, 27KΩ, .5W, 10%	AB	RC20GF273K	1	
R59,80	Resistor, 10KΩ, .5W, 10%	AB	RC20GF103K	2	
R64,65	Resistor, .2Ω, 3W, 3%	SAGE	1300S.2-3	2	
R72	Resistor, 4KΩ, 10W, 5%	WL	10XM4000	1	
R75	Resistor, 1.5KΩ, 5W, 5%	WL	5XM1500	1	
R83	Resistor, 59.95KΩ, .5W, .5%	IRES	CECTO	1	
R88	Resistor, 10Ω, 2W, 10%	IRES	BWH	1	
R79	Resistor, 150KΩ, .5W, 10%	AB	RC20GF154K	1	
R79	Resistor, 15KΩ, .5W, 10%	AB	RC20GF153K	1	
R90	Resistor, 2.5Ω, 50W	IRES	4D	1	

LIST OF ELECTRICAL PARTS - STANDARD UNIT

Designation	Component	MFR	Part Number	Spares	
R96	RES 5K 3w 3%	SAGE	1300S5000-3	1	
R97	RES 700 3w 3%	SAGE	1300S700-3	1	
S1	SWITCH DPST	CARL	NST52K	1	
T1	XFORMER HT60-2.5B	TRY		1	




REVISIONS
SYM | ZONE | DESCRIPTION | DATE | APPROVED
A | | 3634 | 9-2-65 | D.R.
B | | ECN Nº 2883 & 2973 | 5-10-66 | DRM PP
C | | ECN Nº 2961 | 8-31-66 | DRM
D | | ECN Nº 3045 | 11-21-66 | DRM
F | | REVISED NOTE 4, ON SCH. WAS 7359 | 1-25-67 | D.R.N.
G | | ECN. Nº. 3155 | 7-24-67 | D.R.M.
H | | CR10 WAS IN751 - ECN-3362 | 9-14-67 | D.R.M.
J | | R98 WAS ADDED - ECN 3782 | 5-1-68 | D.R.M.
K | | C.R4 WAS TP5620A ECN-3875
C.R15 WAS IN4384 - ECN-3966
CR1, CR2, CR4, CR5, CR6, CR8, CR11, CR17, CR18, CR19, CR20, CR21, CR22, CR24, CR29 CR31, CR32 ARE SHOWN AS ECN-3971 | 7-10-68 | RR. JB.
L | | C19 WAS .01 200V - ECN 3974 | 7-15-68 | D.R.M.
M | | ADDED "A" LTR, CHANGED LTR DESIGNATIONS PER ECN 4093 | 3-26-69 | D.R.M.
T1
CR1 IN4384
R1 200 5W
T1 500 60V
CR12 IN1350A
R2 3950
CR13 IN751
R5 150 1%
R3 47K
Q1
TR1132
Q2
16A507
R4 1180 1%
CR14 Z0132
R6 1.96K 1%
R7 1.96K 1%
R8 100 C5 0.047
Q3
Q4
16A507
R9 750 1%
R10 470 1%
R11 1920 1%
Q5
R28 4.7K
Q6 TR1132
CR16 IN4384
R12 1K
C6 .0033
*R80 10K
*C21 .001
R14 100K
R15 402 1%
CR17 IN4384
R13 560
R17 1.5K
R16 750
Q7
Q8
16A507
C7 .001
R20 100 1%
Q9
Q10
R19 1.96K 1%
R22 5K 1%
R86 150 1½W
MAX E
R21 750 1%
R23 200 1%
CR31 IN4384
R24 50 3W
R87 150 1½W
DS2
(C)
(B)
(G)
(A)
(F)
(D)
(E)
(H)
(K)
(J)
+V
+S
GND
-V
-S
CR4 IN4384
CR5 IN4384
CR3
R52 1K-2W
R53 5K 1½W
R54 10M
CR6 IN4384
R59 10K
R58 27K
CR9 IN4384
Q18
TR1132
R49 25K
R60 100K 1%
R78 150K
C20 .1 200V
R61 22K 1%
CR11 IN751 R57 330K
R48 10K 1%
C2 .15 200V
C11 .22 200V
R46 22K 1%
CR10 IN755A (5%)
Q11 UJ25
C3 0.1 200V
R47 100K 1%
C4 60 50V
R45 82
CR15 UZ724
R79 15K
CR26 IN4384
CR29 IN4384
C19 0.01 600V
R73 100
DS1
CR7 SCR-93-4
L1
C25 0.01 200V
CR26 IN4384
CR27 IN 4384
L2
CR8 SCR-93-4
R55 10
R56 10
R88 10 2W
S1 DS-200 (BLU)
F1 10A
AC G AC
TR1493 Q15
TR1493 Q16
R64 0.2 3W
R89 100
CR19 IN4384
Q17 TR1493
R65 0.2 3W
R41 470
CR20 IN4384
Q14 TR1591
Q13 TR656
R43 470
R42 22K
R76 1K
Q21 16A507
R77 1K
CR35 IN4384
R72 4K 10W
R90 1.2 50W
R33 0.2 25W
CR22 IN751
R38 100 1%
R36 1.96K 1%
R37 150 1½W
MAX I
R35 1.95K 1%
Q12 16A507
R34 604
CURRENT ADJ.
R84 100 2W
R31 10 2W
R29 300 1½W
CURRENT VERNIER
R32 340 1%
C23 20 100V
C9 3300 70V
CR33 E016
CR18 IN4384
M1 0-60V
R98 1K
R83 59.95K 1%
M2 0-5A
R81 150 1½W
R82
5A SHUNT
C17 18 150V
R75 1.5K 5W
C16 8000 75V
R96 5K 5W
R97 700 3W
R25 6.5K 3W
VOLTAGE ADJ.
C22 18 100V
R26 100 2W
VOLTAGE VERNIER
RVP
+V
+S
GND
-V
-S
NORMAL VI
CONSTANT CURRENT MODE
INTERCONNECTION DIAGRAM
TRYLINK PRECISION CURRENT REGULATION MODE
LIST OF MATERIALS OR PARTS LIST
QTY REQ | M | NOMENCLATURE OR DESCRIPTION | CODE IDENT NO | PART OR IDENTIFYING NO | SPECIFICATION | MATERIAL OR NOTE | UNIT WT | ZONE | ITEM NO
NOTES:
1. ALL RESISTORS ½ WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN MICROFARADS.
3. * SELECT AT TEST.
4. LETTERS (A) TO (H) FOR 0V CIRCUIT SEE DWG NO. 7360
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES
DRAWN P. H. E. 2-20-65
CHECKED
ENGR
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
TRYGON ELECTRONICS INC.
ROOSEVELT NEW YORK
MODEL HR 60-5B
SCHEMATIC
CODE IDENT NO 09206
SIZE D
7047
REV M
SCALE
SHEET